Handbook for DRILLERS

HANDBOOK
for
DRILLERS

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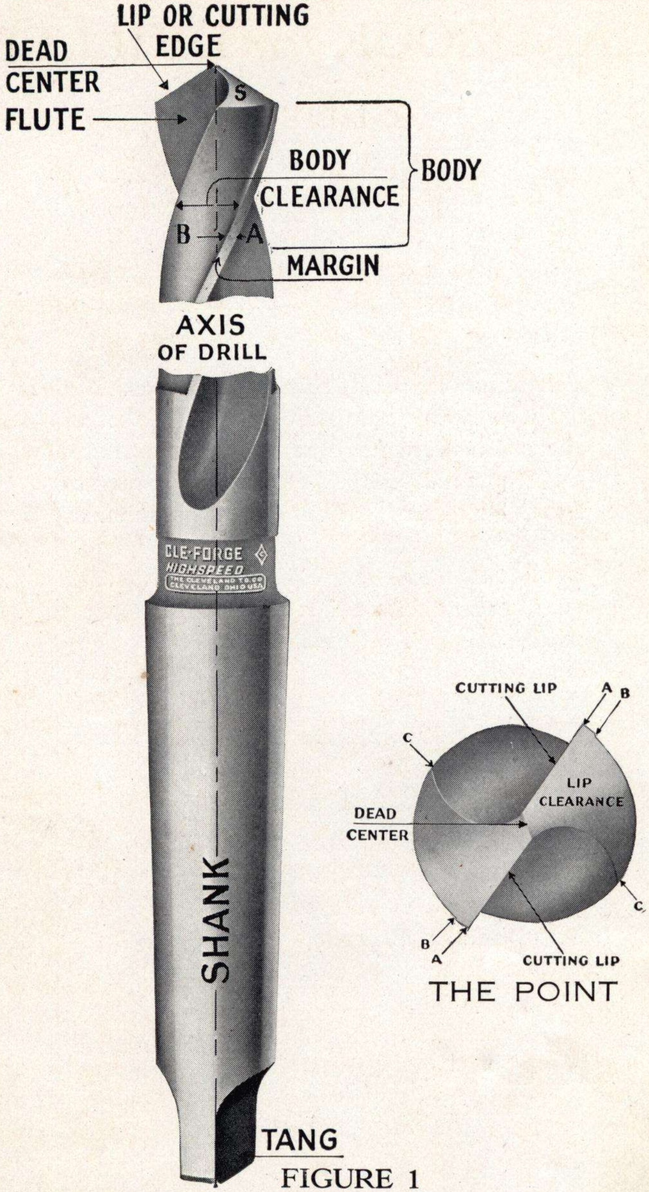
Introduction

THE "Handbook for Drillers" is written for the student of drills and drilling. So popular has it become that it is now in its Eleventh Edition. It is not intended as a complete treatise on the subject, but rather as an introduction to the theory underlying the use of the twist drill.

In view of the fact that the "Handbook" is the only work of its kind on twist drills, the publishers are glad to observe that, more and more, it is being eagerly sought by colleges, technical and vocational schools both in the United States and abroad, as a textbook. Many thousands of copies, each year, are distributed for educational use, without charge. Teachers are always welcome to as many copies as they can conveniently use. Manufacturers with apprentice schools also find it an excellent manual for their boys.

The same material presented in this "Handbook" is also contained in an extremely interesting motion picture entitled "*The Uses and Abuses of Twist Drills.*" This film is in no sense an advertising feature, but is confined to a rather strict interpretation of its title.

The publishers are always glad to furnish this film, for exhibition, to responsible firms and schools. When desired, a portable projector operated from any lamp socket can be provided.



THE POINT

FIGURE 1

The Parts of a Twist Drill

HANDBOOK *for* DRILLERS

CHAPTER I

The Parts of a Twist Drill

1 The twist drill is a special cutting tool—generally formed by milling a cylindrical piece of tool steel, or by forging and twisting grooves in a flat strip of tool steel.

2 A twist drill may be divided into three principal parts—the "Point," the "Body" and the "Shank." The cone-shaped surface at one end is called the "*Point.*"

3 Two spiral grooves run along opposite sides of the drill. These grooves are known as *Flutes*. They are so shaped as to do four things:

(*a*) They help form the proper cutting edges on the cone-shaped "Point."

(*b*) At their junction with the cutting edges they are so shaped as to curl the chip tightly within itself—so that it occupies minimum space.

(*c*) The flutes also form channels through which the chips escape from the hole—

(*d*) And allow the lubricant to get down to the cutting edges.

4 *The Dead Center* is the sharp edge at the extreme tip end of the drill. It is formed by the intersection of the cone-shaped surfaces of the "Point." It should always be in the exact center of the axis of the drill. (Fig. 1).

5 *The "Point"* of the drill should not be confused with the "Dead Center." The "Point", as we use the word in this little volume, is the *entire cone-shaped* surface at the cutting end of the drill. (Fig. 1.)

6 *The Heel* is the portion of the "Point" back of the "Lips" or Cutting Edges.

7 *The Lips* (sometimes called "Cutting Lips") are the cutting edges of the drill. They are formed by the intersection of the flutes and the cone-shaped "Point." (See Fig. 1.)

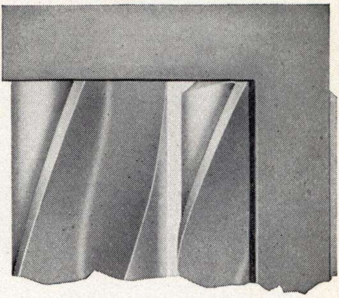


Fig. 2 — Lip Clearance

The drill on the left has no "lip clearance." The one on the right is properly cleared. See paragraphs 8, 9, 10 and 21 to 31.

8 Of course, a real *cutting* edge would not be formed at this intersection, if the surface of the "Point" were at only a 90 degree angle to the plane of rotation (Fig. 2). Under such a condition the "edge" would be merely a square "corner" — too blunt to penetrate.

9 Therefore, in order to give a real *cutting* edge to the Lips, the surface of the "Point" is ground away or "relieved" — just back of the Lips — (See Fig. 2). This relief is called *Lip Clearance*.

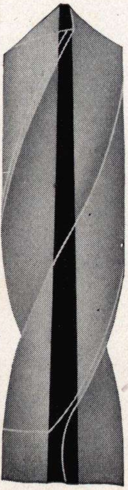


Fig. 3
The Web

The Web is the metal column which separates the flutes.

10 *Lip Clearance* is the shape of the "Point" in relation to the lip. It is one of the most vital subjects discussed in this booklet. Improper grinding of the Lip Clearance is a frequent cause of disaster.

11 *The Margin.* The narrow strip between "A" and "B" (Fig. 1) is called the *Margin*. It is practically the full diameter of the drill and extends the entire length of the flute. Its surface is part of a cylinder which is interrupted by the flutes and by what is known as *Body Clearance*.

12 *Body Clearance.* From "B" to "C" (Fig. 1) is of less diameter than the Margin. This lessened diameter (called *Body Clearance*) reduces the friction between the drill and the walls of the hole, while the Margin between "A" and "B" (which is a full diameter) insures the hole being of accurate size.

13 If it did not have this "Body Clearance" between "B" and "C," more power would be required to overcome the friction between the drill and the wall of the hole. The friction thus generated might be sufficient to draw the temper of the drill itself.

14 *The Web* is the metal column which separates the flutes. It runs the entire length of the drill between the flutes. (Fig. 3.) This Web is the supporting section of the drill — the drill's "backbone," in fact. It gradually increases in thickness toward the shank. (Fig. 4.) This thickening of the Web gives additional rigidity to the drill.

15 Were the two spiral sections of the drill not tied together by the Web, under pressure they would compress like a spring, and if we were to try to drill with these sections, the twisting strain of the drilling would tend to lengthen the drill by actually *untwisting* the flutes. The Web overcomes both these tendencies.

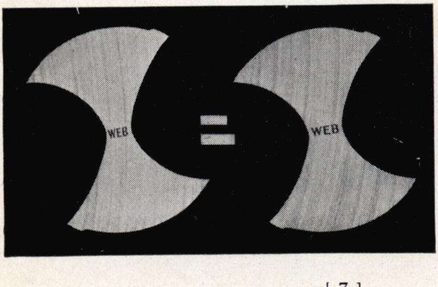


Fig. 4
Sectional View of Web

The section on the left was cut from a drill near the *point* while the section on the right was cut near the *shank*. The difference in the thickness of the web at these two points is shown by the length of the white lines between the two sections in the illustration.

16 The thickening of the Web as it nears the shank naturally decreases the area of the flutes. Unless compensated for in some manner, it would seriously handicap the chips in their escape from a deep hole.

17 Therefore, to offset the thickening of the web, the flutes *widen* as they approach the shank. Thus the sectional area of the flutes remains substantially the same throughout their length.

18 *The Shank* is the end of the drill which fits into the socket or spindle or chuck of the drill press. There are a number of types of shank, the most common of which are illustrated in Fig. 5.

19 *The Tang* is usually found only on taper shank tools (Fig. 5). It is the portion of the tool which fits into a slot in the socket or spindle. It may bear a portion of the driving strain, although its principal use is to make it easy to remove the drill from the socket — called "Drifting." (See Par. 94, 95 and 96 and Fig. 25).

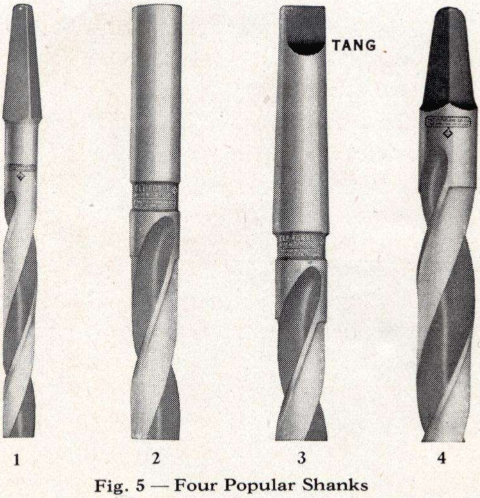


Fig. 5 — Four Popular Shanks

1. The bit stock shank. 2. The straight shank. 3. The taper shank. (Note "tang.") 4. The rachet shank.

CHAPTER II

Points on Grinding

20 Fully 95 per cent of the difficulties encountered in drilling arise from a faulty grinding either of the "Point" or the "Lip Clearance."

21 In grinding a drill, three things must be considered:

(*a*) Lip *Clearance*.

(*b*) The *Length* and *Angle* of the Lips.

(*c*) The Location of the "Point" and "Dead Center" in Relation to the Axis or Center of the Drill.

"Lip Clearance" — Its How And Why

22 Lip Clearance is most generally misunderstood. Lip Clearance is the "relief" which is given the cutting edges in order to allow them to enter the metal without interference.

23 To make clear just exactly what Lip Clearance *is* and what it *does*, let's look at a drill without *any* Lip Clearance. (Fig. 6.) Imagine this drill trying to cut into a piece of steel. It would be impossible — because the surface "S" would always be in contact with the metal and would effectively prevent the cutting edge from biting further into the metal. Such a drill would merely *rub* — around and around —without penetrating.

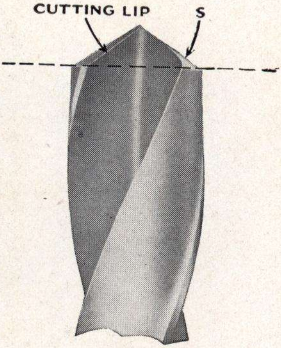


Fig. 6

Showing a drill point without any clearance. Note that both the cutting lip and the heel "S" are in the same plane.

24 Therefore, if the Lip is to penetrate, if its edge is to *cut*, we must grind away the surface "S" back

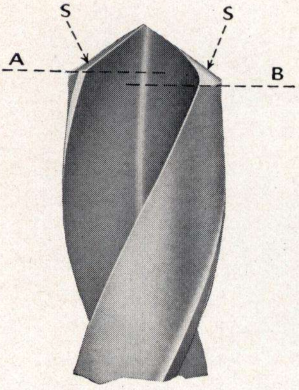


Fig. 7

Proper Lip Clearance

Note how much lower the heel line "B" is than the cutting lip line "A." This difference is the measure of the clearance.

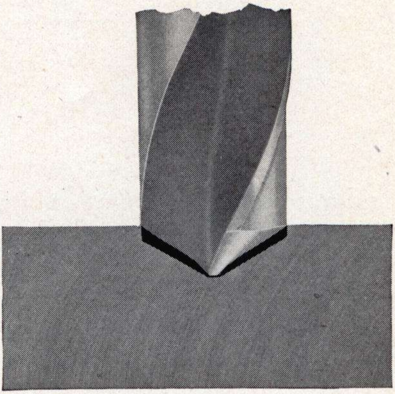


Fig. 8

The cutting lip has already removed considerable metal ahead of the Heel as indicated by the black portions of the hole on each side of the drill.

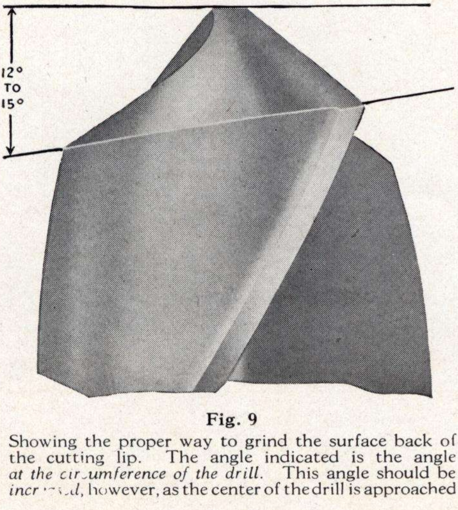


Fig. 9

Showing the proper way to grind the surface back of the cutting lip. The angle indicated is the angle *at the circumference of the drill.* This angle should be *increased,* however, as the center of the drill is approached of the lips (this grinding away is called giving a drill "relief") so that the lip can penetrate the metal. (Figs 2, 7 and 8).

25 A somewhat similar purpose is served by the bevel or "relief" or Lip Clearance which is given a carpenter's plane. (Fig. 8A.)

26 This Lip Clearance is very important. In fact the effectiveness and life of a drill depend to a large degree on the correct forming of this Clearance. Bear in mind that it is not merely ground on the *circumference* of the drill but is applied to the *whole surface* of the point "S" (Fig. 1) back of the Lip. (See Par. 8 to 10.)

Angle of Lip Clearance

27 *The Heel* (the surface of the point back of the cutting lip) should be ground away from the cutting lip at an angle of about twelve or fifteen degrees — as in Fig. 9. In all cases, this angle of twelve to fifteen degrees is the angle *at the circumference of the drill.*

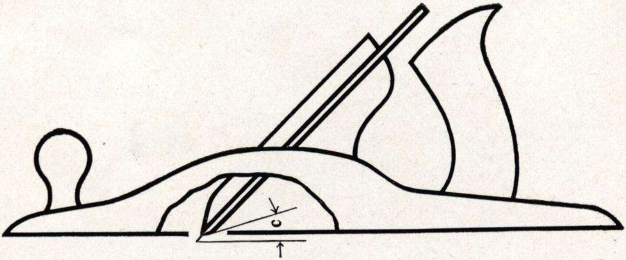


Fig. 8A

Showing the bevel or relief or lip clearance which is given a carpenter's plane — "C being the clearance angle. Practically the same purpose is accomplished by the lip clearance given a drill — it permits the cutting edge to penetrate.

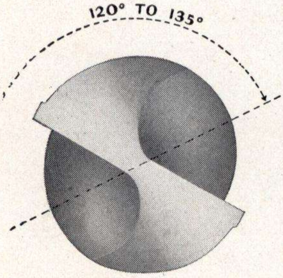


Fig. 10

Showing one way to gauge the correctness of your lip clearance angle.

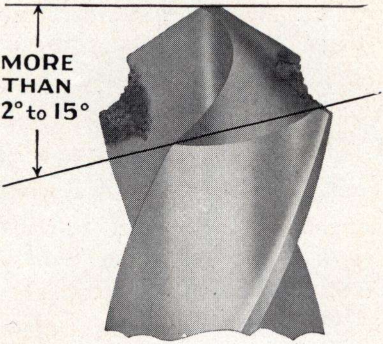
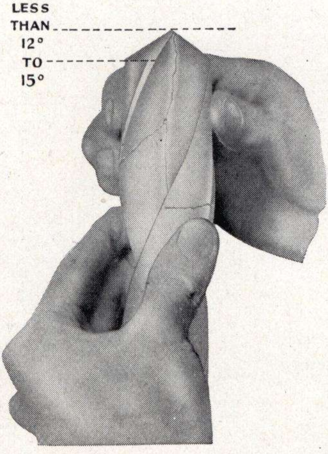


Fig. 11

Showing results of giving a drill too *great* lip clearance — the edges of the cutting lips have broken down because of insufficient support.



Fit. 12

Here the drill was given insufficient lip clearance. As a result there ceased to be any cutting edges whatsoever and, as the feed pressure was applied, the drill could not enter the work — as a result it "splits up the center."

28 *This angle of lip clearance should be gradually increased, however, as the center of the drill is approached* — until the line across the dead center of the drill stands at an angle with the cutting edges of not less than 120 degrees, or it may be as much as 135 degrees — as in Fig. 10.

29 For heavy feeds in soft material, the angle of lip clearance may be safely increased to the full fifteen degrees. Care should be taken, however, to see that the angle at the *center* of the drill — near the tip — is increased proportionally.

Results of Faulty Angle of Lip Clearance

30 If the angle of lip clearance is too great, the edges of the cutting lips will break down (as in Fig. 11) when the drill starts to work, because they will not have sufficient backing to support them—just as a razor edge breaks down if used for cutting tin, because it is too thin and lacks sufficient support to withstand the strain.

31 If *insufficient* surface is ground away; in other words, if the angle is made *less* than twelve degrees, the clearance of the point is so reduced that it ceases to be a cutting edge and refuses to bite into the metal—as in Figs. 2 and 6. This condition may result in splitting the drill up the center. (Fig. 12.)

The Lips and Their Requirements

32 After we have properly ground the "Point" — so that the angle of lip clearance is correct — our work is only half done. We must next cross-check our point grinding and assure ourselves that:—

(*a*) The two lips are the same length—(Fig. 13).

(*b*) The angles of both lips (in relation to the axis of the drill) are equal and correct — 59 degrees is recommended as the best angle for ordinary purposes. (Fig. 13.)

33 If the lips are at the same *angle* to the axis and if they are of equal *length,* the third requirement of good grinding (Par. 21) namely, the *central location of the "Point" and "Dead Center,"* will be fulfilled.

Results of Faulty Lip Angles

34 If the angle of the cutting edges is *more* than 59 degrees, as in Fig. 14, the drill will not center properly, because the cone-shaped "Point," which should hold it in position, will be too nearly flat to perform this work.

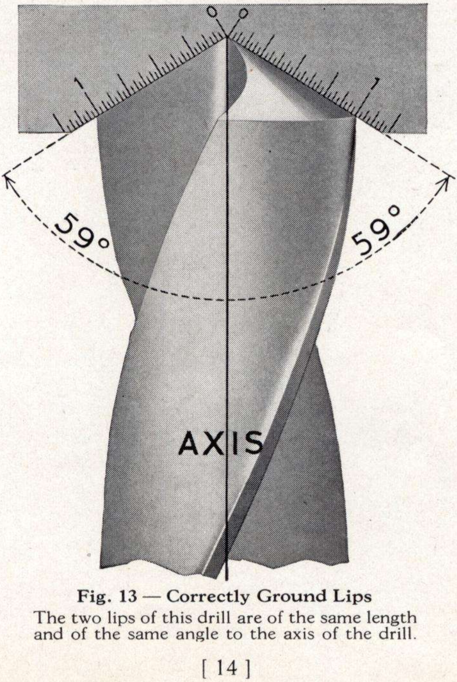


Fig. 13 — Correctly Ground Lips
The two lips of this drill are of the same length and of the same angle to the axis of the drill.

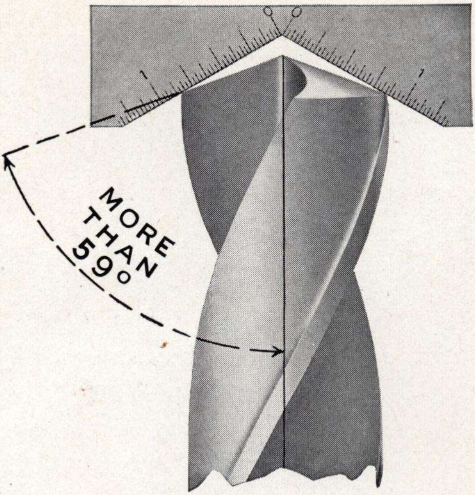


Fig. 14 — Incorrectly Ground Lips

In this case the angle of the lips with the axis of the drill is considerably *more* than 59 degrees. As a result the drill will fail to "center" in the work.

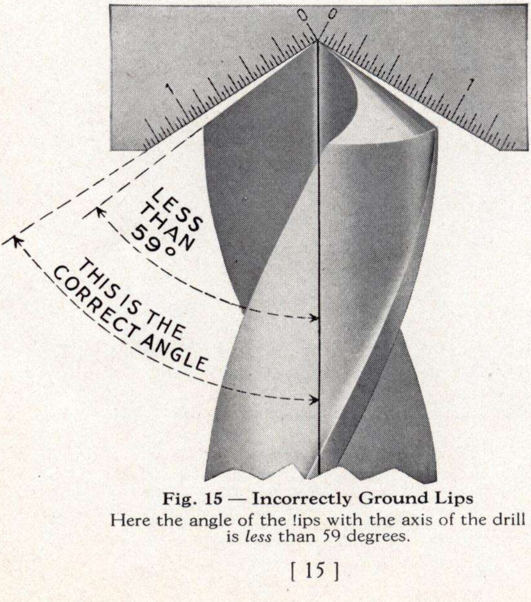


Fig. 15 — Incorrectly Ground Lips

Here the angle of the lips with the axis of the drill is *less* than 59 degrees.

35 If the angle of the cutting edges is *less* than 59 degrees, as in Fig. 15, the tool drills much less rapidly and more power is required to drive it, because of the additional length of the cutting edges.

36 If we get the "Point" in the center but different *angles* on the cutting edges (Fig. 16), the drill will bind on one side. Only one lip or cutting edge will do the work — with resultant rapid wear on this cutting edge — and the hole will be larger than the drill.

37 Or suppose we get equal *angles* on the cutting edges but, on measuring, we find the *lips* are of *different lengths* —

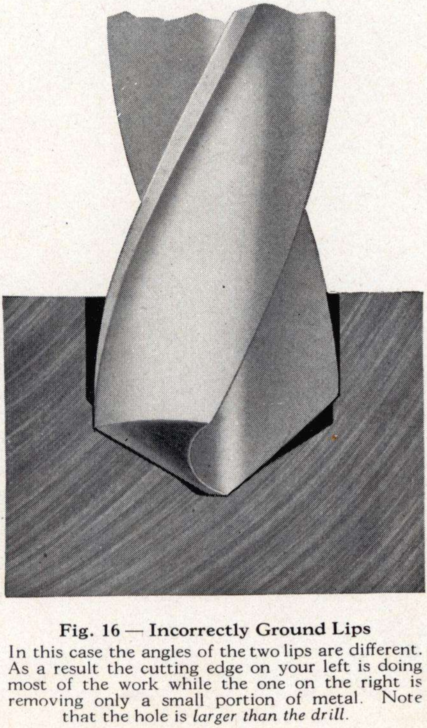


Fig. 16 — Incorrectly Ground Lips

In this case the angles of the two lips are different. As a result the cutting edge on your left is doing most of the work while the one on the right is removing only a small portion of metal. Note that the hole is *larger than the drill.*

as a result both the "Point" and lip will, of necessity, be off center. The result will be a hole actually *larger than the drill.* (Fig. 17.) The effect of this condition is the same as though you put the axle of a wheel any place but in the exact center of the wheel.

38 The resultant strain on the press is tremendous and causes "weaving" or wobbling of the spindle, rapid wearing away of the drill and breakdowns resulting from strains on spindle bearings, etc.

39 Where we combine both of the above faults — unequal angles and lips of different lengths — we have the very

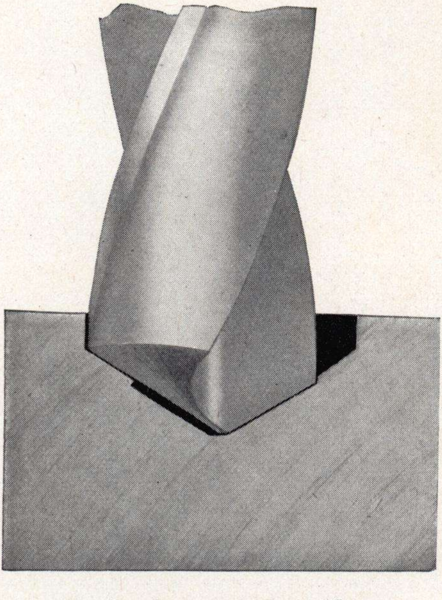


Fig. 17 — Incorrectly Ground Lips
Here the *angles* of the lips are equal but their *lengths* are different. Here again the hole is much larger than the drill and the punishment to the tool is terrific.

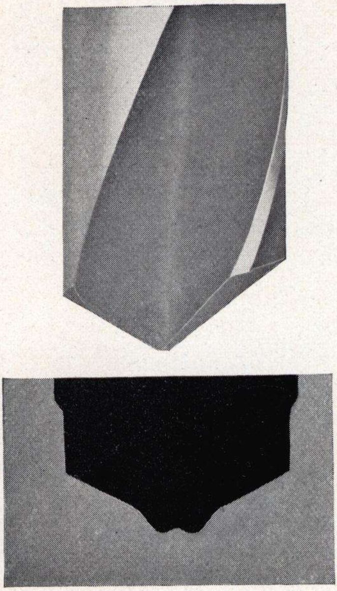


Fig. 18 — Incorrectly Ground Lips
Here the angles of the lips are unequal and the lips are of different lengths. Note the effect on the hole.

peak of abuse. Under these conditions, the hole is larger than the drill and the strain on both the drill and press is terrific. (Fig. 18.)

40 Particular attention is called to Figs. 16, 17 and 18, showing the results of unequal angles of cutting lips and unequal length of cutting lips. Notice how much larger the hole is than the drill. Also notice where the lips are of unequal length (Fig. 17), that the short lip cuts the smaller hole while the long lip cuts the larger hole. Notice also how far from the true center the tip and point of the drill are located in Figs. 16, 17 and 18. This causes a strain which results in a "Side Play" in the drill press spindle.

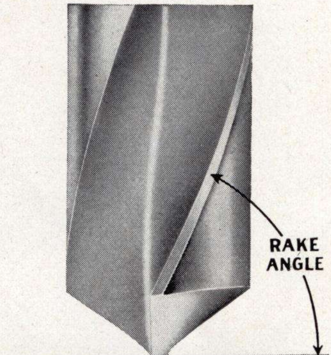


Fig. 19 — The Rake Angle
The "rake angle" is the angle of the flute in relation to the work.

41 *Rake Angle* — Another part of the drill which performs an important function is the "Rake Angle." This is the *angle of the flute in relation to the work* — as in Fig. 19.

42 If the "Rake Angle" were 90 degrees or more, it would not make a good cutting edge. If it is ground with too *small* an angle, however, it makes the cutting edge so thin that it breaks down under the strain of the work.

43 In addition, the "Rake Angle" also partially governs the *tightness* with which the chips curl (within themselves), and hence the amount of space which the chips occupy. Other conditions being the same, a very great "Rake Angle" makes for a tightly rolled chip while a rather small "Rake Angle" gives the chip a tendency to curl into a more loosely rolled spiral.

44 The "Rake Angle" should not be altered except under special conditions — see Par. 68. For ordinary drilling the "Rake Angle" established by the manufacturer of the drill is correct and should remain untouched.

45 Fig. 19A shows "Rake Angle" on a carpenter's plane and on a lathe tool.

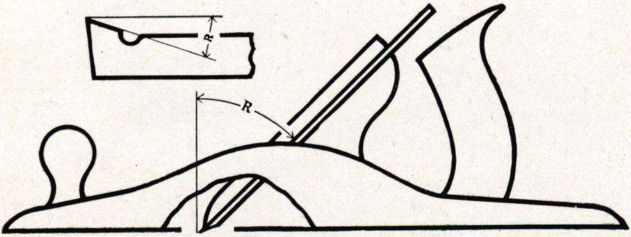


Fig. 19A

This shows rake angle ("R" in the illustration) on a carpenter's plane and on a lathe tool. The similarity with the rake angle of the drill in Fig. 19 is clearly seen.

CHAPTER III

Drill Speeds and Feeds

46 When we refer to the "Speed" of a drill, we mean the speed at the *circumference* — called the "peripheral speed." "Speed" refers to the distance the drill would travel, if for example, it were laid on its side and rolled. Thus a drill with a peripheral speed of 30 feet a minute would *roll* 30 feet a minute. "Speed" as generally used does *not* refer to "rotation per minute" unless specifically stated.

47 *Feed.* Except under certain rather rare conditions, a drill does not pull itself into the work like a corkscrew — it requires constant pressure or "feed" behind it to advance it. This advance (measured in fractions of an inch per revolution) is called "Feed." Feed *Pressure,* however, is the *pressure* required to maintain the "feed."

48 The feed is operated either by hand or power — to force the drill into the work.

49 Opinions differ regarding the correct speed and feed. Therefore, we must come to the conclusion that no hard and fast rule can be given. The following suggestions should be considered merely as guides.

50 Under any given condition, the correct feed and speed can only be determined by good sound judgment in each particular case.

Starting Speeds and Feeds

51 In starting a drill, bring it down to the work by hand feed until it centers itself in the work. *Then* throw in your power feed.

52 It is a safe rule to start drills made of carbon steel with peripheral speed of 30 feet per minute—if they are working in soft tool or machinery steel. This should be increased

to 35 feet per minute for cast iron and 60 feet per minute for brass.

53 The starting *feed* should vary from .001 to .004 of an inch per rotation for drills ¼ inch and smaller in diameter; from .004 to .007 of an inch for drills from ¼ inch to ½ inch; for drills larger than ½ inch .005 to .015 inch per rotation.

54 At these speeds and feeds, a good cutting compound is recommended. See Pars. 79 to 85.

Speed and Feed for High Speed Drills

55 In the case of high speed drills, the above *feeds* should remain unchanged — the starting *speed*, however, should be increased to 80 feet per minute.

56 We suggest that you start the drill with a moderate speed and feed, increasing either one — or both — after observing the condition of the drill. That your observations may be intelligent and your adjustment of speed and feed based on the requirements, carefully observe the following suggestions:

Indication of Too Much Feed

57 If the drill *chips out* at the cutting edge, it is a sure indication of too heavy a feed or too much lip clearance. (See Pars. 22 to 40.)

58 A drill which *splits* up the web (Fig. 12) is also evidence of too much feed for the amount of lip clearance. Decrease the feed or increase the lip clearance — or both. (See Par. 31).

59 The failure to give sufficient lip clearance at the *center* of a drill will cause it to split up the web.

60 On the other hand, *too much* lip clearance at the center (or at any other point on the lip) causes the cutting lips to chip.

61 Therefore, before blaming the feed, it would be well to make sure that the drill is properly ground. If it is properly ground, decrease your feed.

Indications of Too Much Speed

62 When the extreme outer corners of the cutting edges wear away too rapidly (Fig. 20), it is evidence of too much speed. (See Par. 52.)

63 High speeds in cast iron tend to wear away the margin of the drill; 35 feet per minute peripheral speed is the maximum we would suggest for carbon drills in cast iron. The feed may be from .007 to .015 inches per rotation, according to the hardness of the metal being drilled.

General Recommendations

64 In general, a high speed and light feed is recommended. It is better to err on the side of too much *speed* than to err on the side of too much *feed* (except for cast iron where the nature of the material may permit an unusually heavy feed).

65 The speed can be increased to the point where the outside corners commence to show signs of wearing away (Par. 62). It can then be slightly reduced and maintained at this reduced figure.

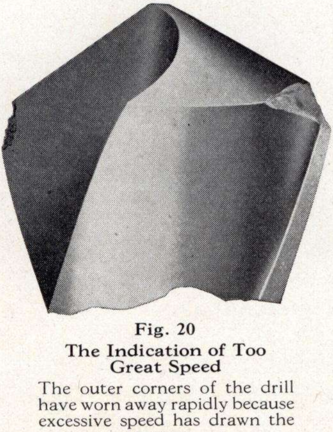


Fig. 20

The Indication of Too Great Speed

The outer corners of the drill have worn away rapidly because excessive speed has drawn the temper.

CHAPTER IV

Miscellaneous Helps

Drilling Hard Material

66 Very often, even after you have ground the drill properly and increased the speed to the extreme limit, the drill still fails to penetrate.

67 This is usually caused by a *hard spot* in the material itself. It can be remedied — or at least materially helped — by liberal application of turpentine directly to the work.

68 The drill may be assisted in almost any hard material by the use of turpentine or kerosene. Another method is to reduce the entering angle of the lips or the "Rake Angle" as it is sometimes called (See Pars. 41 to 45), as in Fig. 21, so as to permit the use of a heavy feed pressure. If a heavy feed pressure were used without first grinding the sharp angles off the lip (called "Raking") as in Fig. 21, the drill would chip severely on the lips.

69 This removal of the sharp angle of the lips, however, must be done with extreme care and judgment, or the drill will have to be re-ground throughout.

70 Variations in the hardness of the material drilled can only be met by the skill of the operator and his adjustments of the combination of speeds and feeds.

71 The commercial twist drill is tempered for average conditions—to give good

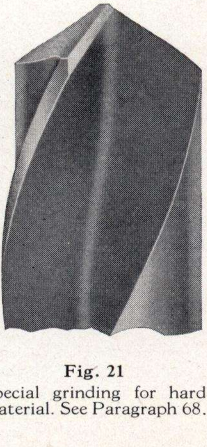


Fig. 21
Special grinding for hard material. See Paragraph 68.

results in a wide variety of hard and soft material. Sometimes specially tempered drills are used on unusually hard material, but such special drills must be made to order. Their use can usually be avoided by a skilled manipulation of the speed, feed and lubricant.

72 "The harder the metal the lighter the feed and slower the speed" is a rough and ready sort of rule.

Small Hole Drilling

73 In drilling holes of small diameter, unless the feed and speed are given unusually careful attention, the danger of breakage is very great — especially at the moment the point of the drill *breaks through* the other side of the work.

74 Particularly is this moment dangerous when the hand feed is used, because, when you are using the hand feed, it is difficult to regulate the pressure you apply to the feed lever with any degree of exactness.

75 In some shops, specializing in the manufacture of wool combs and similar products, thousands of holes as small as .013 inch in diameter are drilled daily through brass plates $\frac{7}{16}''$ thick. This work is accomplished without difficulty by carefully grinding the drills, honing them on a whetstone and running at 20,000 revolutions per minute. This speed is increased up to 30,000 revolutions per minute when the holes are as small as .013″. Outside of this particular industry, *it is rare to run across a small drilling machine running at better than one-quarter of its proper speed.*

76 Therefore, let us urge you, when drilling with small drills, to lean rather toward too much speed than toward not enough — and keep the feed light.

Drilling Brass

77 Owing to the nature of brass, a heavier feed than for the harder materials may be used, especially in automatic machines, in order to insure the chips having sufficient body to follow the flutes out of the hole. For brass work, if any lubricant is used, paraffine oil is suggested. A special drill is made for brass work. In ordering specify No. 1207 or No. 1208 "for brass."

78 The form of point described in Paragraphs 90 to 92, will also be found efficient in drilling soft material such as brass —where the normal point has a tendency to "hog in" or "grab."

Cutting Compound for Various Metals

79 To maintain the speeds and feeds recommended it will be found necessary to use some good cutting compound, and we recommend the following in the order named:

80 For hard and refractory steel — turpentine, kerosene, soda-water.

81 For soft steel and wrought iron — lard oil, soda-water.

82 For malleable iron — soda-water.

83 For brass — a flood of paraffine oil, if any.

84 For aluminum and soft alloys — kerosene, soda-water.

85 Cast iron — should be worked dry or with a jet of compressed air for a cooling medium.

Drilling With Automatic Machines Under Flood of Lubricant

86 For automatic machines where holes do not exceed two drill-diameters in depth, and under a flood of cutting lubricant, high speeds and light feeds are especially recommended.

When The Chips Clog in the Hole

87 When holes are deeper than two drill-diameters, it is sometimes difficult to get rid of the chips. A point like Fig. 21 is especially efficient under these conditions — with slower speed and heavier feed as the bottom of the hole is approached.

Hint For Automatic Drilling

88 Always endeavor in automatic drilling to get a small, compactly rolled chip (Fig. 22) and if possible keep it unbroken the entire depth of the hole as such a chip feeds out through the flutes most easily.

Rough Hole

89 Where the drill seems to be drilling fairly well, yet the surface of the hole is rough, it is an indication that the drill is dull and should be re-sharpened. (Fig. 23.)

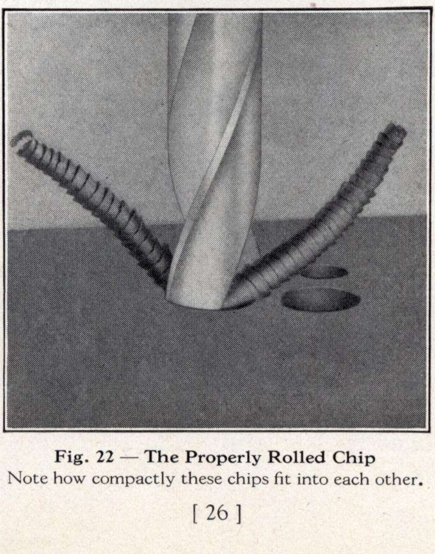


Fig. 22 — The Properly Rolled Chip
Note how compactly these chips fit into each other.

"Thinning the Point"

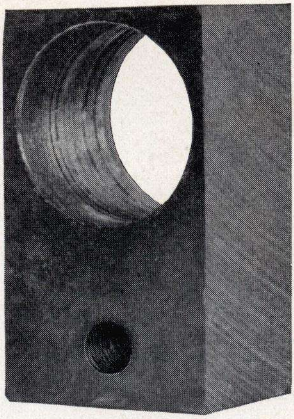


Fig. 23
A rough, inaccurate hole — the result of a dull drill.

90 Drills may be made to feed into the work more easily by a process known as "thinning the point." This is an extremely delicate operation, and is not recommended except in the hands of a skillful operator. It is, however, a decided assistance where the hand feed is used, or where you are using high speed drills with unusually heavy webs.

91 To properly thin the point, a round-faced emery wheel is necessary. The drill should look like Fig. 24 when finished.

92 Be very careful in "thinning the point" to keep the "Dead Center" of the drill in the exact center and be careful not to weaken the Web too much by running the ground-out section too far up into the flutes.

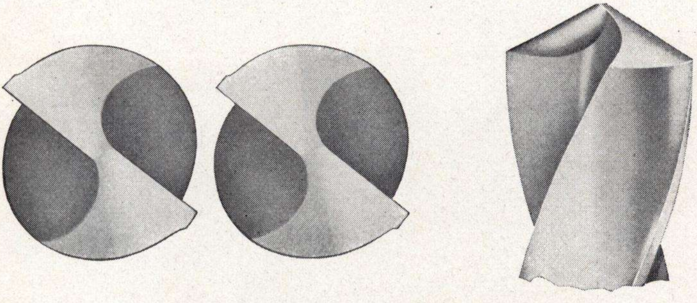


Fig. 24 — Thinned Points
Drills may be made to feed more easily by thinning the point. The drill in the center has not been thinned. The one on the left and the right have been thinned. Note the difference in the thickness of the web at the dead center before and after "thinning." See Paragraphs 90 to 92.

CHAPTER V

Common Errors and Their Results

Broken Tangs

93 Broken tangs result from a variety of causes — they may be traced to the use of badly mutilated sockets, to the use of drills whose shanks are so "banged up" that they do not fit snugly into the socket, or to the use of drills with badly mutilated tangs.

94 Although the tang of the drill is designed to carry a portion of the driving strain, the tapered fit between the

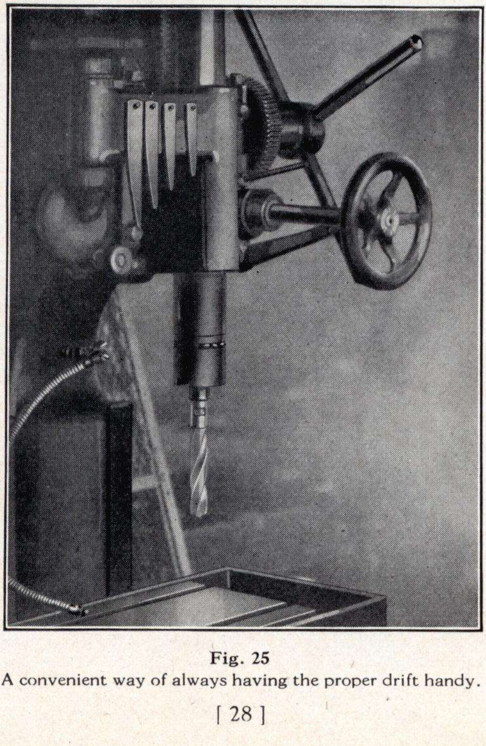


Fig. 25
A convenient way of always having the proper drift handy.

shank of the drill and the wall of the socket should carry a large share of this strain. As a result, if either the inner wall of the socket or the surface of the shank is mutilated, a perfect fit is impossible. Under such conditions the whole driving strain is thrown on the *tang*. Often the tang breaks through no fault of its own — but rather through faulty treatment of either the drill or the socket.

95 Before inserting a drill in a socket, rub off the shank to make certain it is smooth and free from grit. Also inspect the inside of the *socket* to be sure it is in the same condition. "Cleveland" sockets have an angle in the drift slot which prevents the upsetting or damaging of the edges of the tang while drifting. This is a great convenience.

How to "Drift Out"

96 In drifting a drill out of the socket, never use anything but a drift (Fig. 25). The use of such makeshifts as files or wedges is likely to permanently injure either the drill or the socket or both—with broken tangs resulting therefrom.

97 In removing the drill from the spindle or socket, take great care that the point or tip does not hit the table of the press or the work. It is well to have a bit of wood handy onto which the drill can drop as you drift it out.

Use A Lead Hammer

98 In inserting a drill into the socket, never use a machinists' hammer, as this dulls the tip of the drill and nicks the cutting edges. Always use a material considerably softer than the drill itself—such as a lead hammer, or a piece of wood "2 x 4."

Necessity of Rigidity

99 One of the most common causes of drill breakage is lack of rigidity in the press or the work. Drill presses which are too weak to resist the feed pressure without springing, due either to faulty design of the table or of the feeding parts, and drill presses having lost motion in the spindle, invite breakage, because the sudden release of the resistance to the feed pressure when the point breaks through the far side of the work, causes the lips to bite too deeply into the work. This causes the lips to catch and sufficient strain results to break the drill.

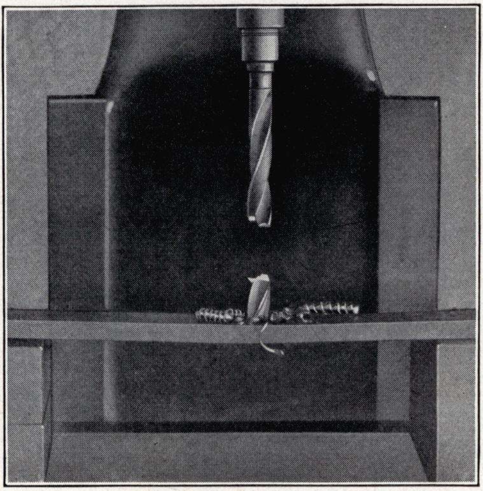


Fig. 26 — The Result of Spring
Spring in the work or the drill press is likely to produce the same result — breakage.

100 The same results come about from faulty setting up of the work. Underneath the drill, the work should be absolutely rigid and free from spring. Otherwise breakage is almost sure to result. (Fig. 26.)

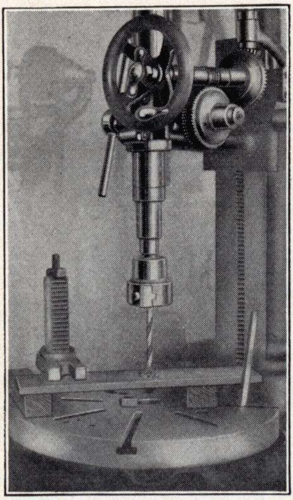


Fig. 27

The work should always be clamped to the table. Otherwise it may catch in the drill and do harm to the operator.

Use The Clamp

101 The work should never be held in the hand. It should be rigidly *clamped* to the table of the press. (Fig. 27.) Where the work is held in the hand, the danger of breaking, owing to lack of rigidity and side support, is tremendously increased, and the danger to the operator resulting from whirling work is considerable. (Fig. 28.)

Warm High Speed Drills Before Using

102 It is a good practice to warm the lubricant before using it with high speed tools. Any hard piece of steel is extremely brittle when cold, and high speed drills should never be put to work in that condition. They work much better when warm — often giving good results when the chips are actually turned blue by the heat generated.

103 Nothing will "check" (fill full of small cracks) a high speed drill quicker than to turn a stream of cold water onto it after it has become heated while working. It is equally bad to plunge it in cold water after the point

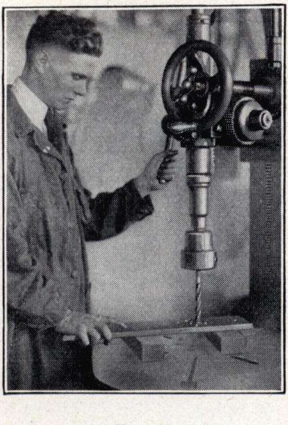


Fig. 28

The wrong way to set up a job — never hold it with your hand. Always clamp it.

has been heated in grinding. Either of these practices is certain to impair the strength of the drill.

Filing Not Reliable Test of Cutting Ability

104 A fact often lost sight of, even by experienced users of drills, is that *cutting ability* and *hardness* are not the same thing. This is especially true of high speed drills. The apparent hardness of a drill varies with the composition of the steel and is no indication of the cutting ability.

105 Some of the best high speed tools we have ever tested could be filed so readily that — if filing were an indication of the work to be expected of them — they would be condemned without a working trial.

106 A high speed drill so hard that it cannot be filed, may by exercising great care, be made to drill extremely hard material. But such a drill will be found so *brittle* as to be worthless if used for softer materials, or where a large amount of work must be done in a given time.

107 Numerous tests have proven that the hardness of files varies quite as much as that of other hardened tools, and this is another reason why file tests are unreliable. No drill that files hard or soft should be condemned for that reason alone, but should first be given a drilling test in material of known hardness.

Key to Table of Cutting Speeds

THE table of Cutting Speeds shown on opposite page, should be used only as a guide and the correct speeds for drills should be determined by good judgment applied to each individual case. It is safe to start carbon drills with a peripheral speed of 30 feet per minute for soft tool and machinery steel, 35 feet for cast iron and 60 feet for brass, using in all cases a feed of from .001 to .004 inch per rotation for drills ¼ inch and smaller; from .004 to .007 inch per rotation for drills ¼ inch to ½ inch; and from .005 to .015 inch per rotation for drills larger than ½ inch in diameter. At these speeds a suitable cutting-compound should be used for wrought iron and steel.

109 In the case of High Speed Steel Drills the above feeds should remain unchanged, but the speeds should be increased to 80 feet per minute.

110 All of the speeds recommended are only speeds at which the drilling should be started. They are approximate for average conditions only. They can be greatly exceeded under some conditions, but under others they will have to be reduced. *In all cases* the operator should be guided by observing the condition of the drill in connection with the suggestions on pages 20 to 26.

TABLE OF CUTTING SPEEDS

(Fraction Size Drills)

Feet per Min.	30′	40′	50′	60′	70′	80′	90′	100′	110′	120′	130′	140′	150′
Diameter In.	Revolutions per Minute												
1/16	1833	2445	3056	3667	4278	4889	5500	6111	.....	.....	.....	.....	.....
⅛	917	1222	1528	1833	2139	2445	2750	3056	3361	3667	3973	4278	4584
3/16	611	815	1019	1222	1426	1630	1833	2037	2241	2445	2648	2852	3056
¼	458	611	764	917	1070	1222	1375	1528	1681	1833	1986	2139	2292
5/16	367	489	611	733	856	978	1100	1222	1345	1467	1589	1711	1833
⅜	306	407	509	611	713	815	917	1019	1120	1222	1324	1426	1528
7/16	262	349	437	524	611	698	786	873	960	1048	1135	1222	1310
½	229	306	382	458	535	611	688	764	840	917	993	1070	1146
⅝	183	244	306	367	428	489	550	611	672	733	794	856	917
¾	153	203	255	306	357	407	458	509	560	611	662	713	764
⅞	131	175	218	262	306	349	393	436	480	524	568	611	655
1	115	153	191	229	267	306	344	382	420	458	497	535	573
1⅛	102	136	170	204	238	272	306	340	373	407	441	475	509
1¼	92	122	153	183	214	244	275	306	336	367	397	428	458
1⅜	83	111	139	167	194	222	250	278	306	333	361	389	417
1½	76	102	127	153	178	204	229	255	280	306	331	357	382
1⅝	70	94	117	141	165	188	212	235	259	282	306	329	353
1¾	65	87	109	131	153	175	196	218	240	262	284	306	327
1⅞	61	81	102	122	143	163	183	204	224	244	265	285	306
2	57	76	95	115	134	153	172	191	210	229	248	267	287
2¼	51	68	85	102	119	136	153	170	187	204	221	238	255
2½	46	61	76	92	107	122	137	153	168	183	199	214	229
2¾	42	56	69	83	97	111	125	139	153	167	181	194	208
3	38	51	64	76	89	102	115	127	140	153	166	178	191

TABLE OF CUTTING SPEEDS

(Number Size Drills)

Feet per Min.	30′	40′	50′	60′	70′	80′	90′	100
Size Number	Revolutions per Minute							
1	503	670	838	1005	1173	1340	1508	1675
2	518	691	864	1037	1210	1382	1555	1728
3	538	717	897	1076	1255	1434	1614	1793
4	548	731	914	1097	1280	1462	1645	1828
5	558	744	930	1115	1301	1487	1673	1859
6	562	749	936	1123	1310	1498	1685	1872
7	570	760	950	1140	1330	1520	1710	1900
8	576	768	960	1151	1343	1535	1727	1919
9	585	780	975	1169	1364	1559	1754	1949
10	592	790	987	1184	1382	1579	1777	1974
11	600	800	1000	1200	1400	1600	1800	2000
12	606	808	1010	1213	1415	1617	1819	2021
13	620	826	1032	1239	1450	1652	1859	2065
14	630	840	1050	1259	1469	1679	1889	2099
15	638	851	1064	1276	1489	1702	1914	2127
16	647	863	1079	1295	1511	1726	1942	2158
17	662	883	1104	1325	1546	1766	1987	2208
18	678	904	1130	1356	1582	1808	2034	2260
19	690	920	1151	1381	1611	1841	2071	2301
20	712	949	1186	1423	1660	1898	2135	2372
21	721	961	1201	1441	1681	1922	2162	2402
22	730	973	1217	1460	1703	1946	2190	2433
23	744	992	1240	1488	1736	1984	2232	2480
24	754	1005	1257	1508	1759	2010	2262	2513
25	767	1022	1276	1533	1789	2044	2300	2555
26	779	1039	1299	1559	1819	2078	2338	2598
27	796	1061	1327	1592	1857	2122	2388	2653
28	816	1088	1360	1631	1903	2175	2447	2719
29	843	1124	1405	1685	1966	2247	2528	2809
30	892	1189	1487	1784	2081	2378	2676	2973
31	955	1273	1592	1910	2228	2546	2865	3183
32	988	1317	1647	1976	2305	2634	2964	3293
33	1014	1352	1690	2028	2366	2704	3042	3380
34	1032	1376	1721	2065	2409	2753	3097	3442
35	1042	1389	1736	2083	2430	2778	3125	3472
36	1076	1435	1794	2152	2511	2870	3228	3587
37	1102	1469	1837	2204	2571	2938	3306	3673
38	1129	1505	1882	2258	2634	3010	3387	3763
39	1152	1536	1920	2303	2687	3071	3455	3839
40	1169	1559	1949	2339	2729	3118	3508	3898
41	1194	1592	1990	2387	2785	3183	3581	3979
42	1226	1634	2043	2451	2860	3268	3677	4085
43	1288	1717	2146	2575	3004	3434	3863	4292
44	1333	1777	2221	2665	3109	3554	3999	4442
45	1397	1863	2329	2795	3261	3726	4192	4658
46	1415	1886	2358	2830	3301	3773	4244	4716
47	1460	1946	2433	2920	3406	3893	4379	4866
48	1508	2010	2513	3016	3518	4021	4523	5026
49	1570	2093	2617	3140	3663	4186	4710	5233
50	1637	2183	2729	3274	3820	4366	4911	5457
51	1710	2280	2851	3421	3991	4561	5131	5701
52	1805	2406	3008	3609	4211	4812	5414	6015
53	1924	2566	3207	3848	4490	5131	5773	6414
54	2084	2778	3473	4167	4862	5556	6251	6945
55	2204	2938	3673	4408	5142	5877	6611	7346
56	2465	3286	4108	4929	5751	6572	7394	8215
57	2671	3561	4452	5342	6232	7122	8013	8903

TABLE OF CUTTING SPEEDS

(Number Size Drills)

Feet per Min.	30′	40′	50′	60′	70′	80′	90′	100′
Size Number	Revolutions per Minute							
58	2729	3637	4547	5456	6367	7275	8186	9095
59	2795	3726	4658	5590	6521	7453	8388	9316
60	2865	3820	4775	5729	6684	7639	8594	9549
61	2938	3918	4897	5876	6856	7835	8815	9794
62	3015	4020	5025	6030	7035	8040	9045	10050
63	3096	4128	5160	6192	7224	8256	9288	10320
64	3183	4244	5305	6366	7427	8488	9549	10610
65	3273	4364	5455	6546	7637	8728	9819	10910
66	3474	4632	5790	6948	8106	9264	10422	11580
67	3582	4776	5970	7164	8358	9552	10746	11940
68	3696	4928	6160	7392	8624	9856	11088	12320
69	3918	5224	6530	7836	9142	10488	11754	13060
70	4091	5456	6820	8184	9548	10912	12276	13640
71	4419	5892	7365	8838	10311	11784	13257	14730
72	4584	6112	7640	9168	10696	12224	13752	15280
73	4776	6368	7960	9552	11144	12736	14328	15920
74	5106	6808	8510	10212	11914	13616	15318	17020
75	5457	7276	9095	10914	12733	14552	16371	18190
76	5730	7640	9550	11460	13370	15280	17190	19100
77	6366	8488	10610	12732	14854	16976	19098	21220
78	7161	9548	11935	14322	16709	19096	21483	23870
79	7902	10536	13170	15804	18438	21072	23706	26340
80	8490	11320	14150	16980	19810	22640	25470	28300

TABLE OF CUTTING SPEEDS

(Letter Size Drills)

Feet per Min.	30′	40′	50′	60′	70′	80′	90′	100′
Size Letter	Revolutions per Minute							
A	491	654	818	982	1145	1309	1472	1636
B	482	642	803	963	1124	1284	1445	1605
C	473	631	789	947	1105	1262	1420	1578
D	467	622	778	934	1089	1245	1400	1556
E	458	611	764	917	1070	1222	1375	1528
F	446	594	743	892	1040	1189	1337	1486
G	440	585	732	878	1024	1170	1317	1463
H	430	574	718	862	1005	1149	1292	1436
I	421	562	702	842	983	1123	1264	1404
J	414	552	690	827	965	1103	1241	1379
K	408	544	680	815	951	1087	1223	1359
L	395	527	659	790	922	1054	1185	1317
M	389	518	648	777	907	1036	1166	1295
N	380	506	633	759	886	1012	1139	1265
O	363	484	605	725	846	967	1088	1209
P	355	473	592	710	828	946	1065	1183
Q	345	460	575	690	805	920	1035	1150
R	338	451	564	676	789	902	1014	1127
S	329	439	549	659	769	878	988	1098
T	320	426	533	640	746	853	959	1066
U	311	415	519	623	727	830	934	1038
V	304	405	507	608	709	810	912	1013
W	297	396	495	594	693	792	891	989
X	289	385	481	576	672	769	865	962
Y	284	378	473	567	662	756	851	945
Z	277	370	462	555	647	740	832	925

Shop Helps

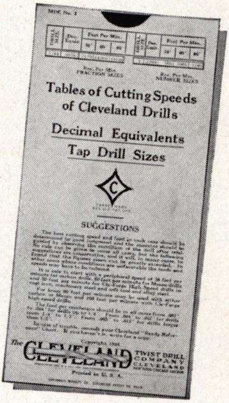
Model Drill Point—No. 190

The student of drills and drilling, as well as many with years of experience, will find this model drill point especially valuable in learning to grind drills properly, so as to do more and better work and keep the number of broken drills down to a minimum.

Price, net, postpaid................55c

Cutting Speed Slide

A handy, convenient cardboard slide giving tables of cutting speeds and decimal equivalents for fraction and number size drills, together with tap drill sizes. The slide also includes some valuable suggestions on speeds and feeds. No charge for this slide.


Tables of Cutting Speeds of Cleveland Drills
Decimal Equivalents
Tap Drill Sizes
SUGGESTIONS
The CLEVELAND TWIST DRILL COMPANY CLEVELAND
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LOOK FOR THESE TRADE MARKS
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MEZZO Drills
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NOTE: DATA APPLIES TO WROUGHT IRON, MACHINERY STEEL, SOFT TOOL AND ALLOY STEEL.
DECIMAL EQUIV.
REV. PER MIN.
FEEDS

A pocket-size celluloid disc giving complete information on cutting speeds at 30, 60, 80, 90 and 100 feet per minute, with decimal equivalents for fraction, number and letter size drills.

Only one disc can be furnished to an individual. Ideal for student and operator alike.

Price, net, postpaid.....25c

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These heavy cardboard charts,—14 pages on 7 cards—contain a wealth of data for the practical shopman. Such as Regular Tapers, Decimal Equivalents, Tables of Cutting Speeds, Information on Speeds, Feeds and Lubricants, Tap Drill Sizes (Coarse and Fine Thread Series), National Pipe Thread and 29° Screw Threads, Acme Standard.

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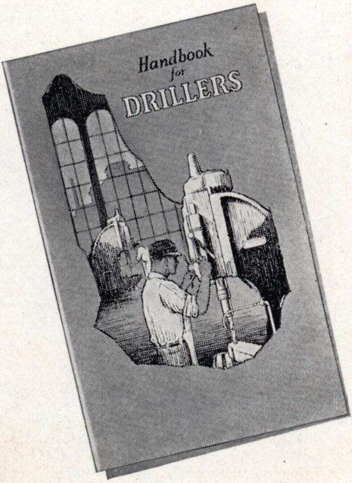
No charge for Ready Reference.

Handbook for Drillers

This book, which you hold in your hand, is used as a textbook by the foremost colleges, technical and vocational schools throughout the world. Thousands of copies are distributed each year for classroom use.

The "Handbook" will be mailed without charge to individuals, and to teachers in any reasonable quantities for distribution to their students.

No charge for this "Handbook."



Some Tools You'll Use

A few examples of the most popular and widely used Cleveland Drills and Reamers

CLE-FORGE HIGH SPEED DRILLS, illustrated by Nos. 940 and 950 below, are probably the most widely known drills made in America by virtue of the world's records they hold for drilling through a 3-inch billet of cast iron at the extraordinary rate of 116 inches per minute and through machinery steel at the rate of 50 inches per minute.

These fine drills represent a "merger" of the best qualities of the forged and milled types, combining into one tool all the toughness and resistance to breakage characteristic of the former, with the fine accuracy of the milled drill.

All Cleveland Drills and Reamers are made in a plant which, for more than 50 years, has been building an enviable reputation for quality in product and performance.

CLE-FORGE High Speed Drill No. 940

This is the regular taper shank drill in high speed steel. Also furnished in carbon steel as No. 106.

CLE-FORGE High Speed Drill No. 950

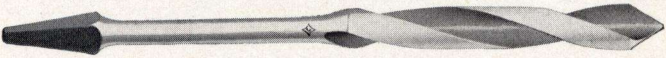
This is the same drill as No. 940, except that it has a straight shank and is "long set;" that is, the overall length of the drill is longer than other drills known as "short set." Furnished also in carbon steel as No. 110.

Jobbers' Straight Shank Drill No. 108

A typical small straight shank drill, "short set;" that is, shorter in overall length than the same size drill in Nos. 110 or 950. Also furnished in high speed steel as No. 917.

Bit Stock Drill No. 114

This drill is intended for use with a brace or breast drill where a bit will hold the tool more firmly than a straight shank. It is used either for metal or wood.



Wood Bit for Brace No. 114A

This tool is somewhat similar to No. 114, except that it will be noted that its end is pointed instead of being blunt. It may be used in a brace or breast drill, but is intended for drilling wood only.

MEZZO Super-Carbon Drills

These drills are so called because, due to the discovery of the action and performance of certain alloys, it has been possible to produce a drill capable of doing from four to six times the work of a carbon drill.

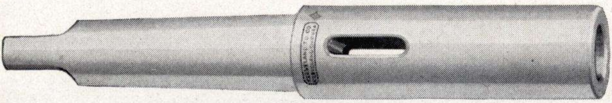
MEZZO Drills are particularly well adapted for drilling brass, bronze, aluminum, cast iron, machine steel and the softer alloys at approximately double the speeds and feeds at which carbon drills can be worked safely. At the same time, MEZZO can be operated at ordinary carbon drill speed and feed, if desired, without the slightest danger, and will do a great deal more work before re-grinding becomes necessary.

MEZZO, however, is not recommended for very hard materials.

MEZZO Taper Shank Drill No. 1006
This drill is identically the same size and style as No. 940 shown on page 38, except that its flutes, recess and tang are a dark, blue-colored steel instead of gray

MEZZO Straight Shank Drill No. 1010
This drill is the same as No. 1006, except that it is of the straight shank, long set, type.

MEZZO Straight Shank, Short Set, Drill No. 1008
A typical MEZZO drill in performance, appearance and color, but otherwise the same as No. 108, shown on page 38.

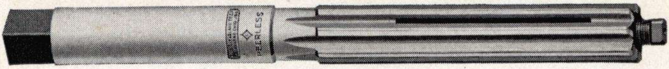


Fitted Socket No. 102
This is a typical Cleveland taper fitted socket for use with all taper shank tools.

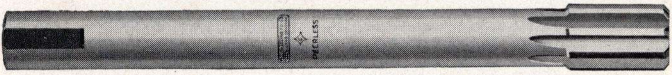
Sleeve, or Shell, Socket No. 104
Great care is exercised in the manufacture of Cleveland Sockets to insure a perfect fit of taper shank tools.

Peerless High Speed Reamers

"Peerless" High Speed Reamers employ an exceedingly *tough* alloy for the body instead of the usual high speed steel. Into this tough, almost unbreakable, alloy body, high speed steel blades are "Brazo-hardened" by a patented process which makes the blades an integral part of the tool. The result is an extremely high-grade, high speed reamer of great toughness, at a marked saving in cost. The same patented process of manufacture enables us to furnish "Peerless" in *expansion* types. "Peerless" is the only high speed solid reamer which can be had in this type. It is, of course, made in all other styles, except the bridge reamer type.

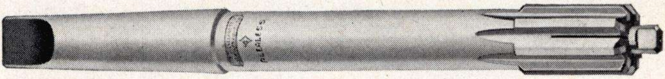


Peerless Expansion Hand Reamer No. 502
A high speed reamer, capable of unusual expansion which adds materially to the life of the tool.



Peerless Straight Shank Chucking Reamer No. 503
A typical example of the non-expansion type of Peerless Reamer. Bear in mind, however, that all Peerless Reamers may be had in either expansion or non-expansion types.

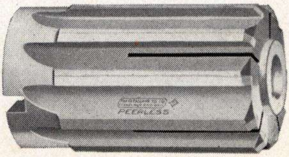
Peerless Expansion Core Reamer No. 510
The only solid high speed expansion core reamer on the market.



Peerless Taper Shank Expansion Chucking Reamer No. 516
This is a taper shank tool, but as No. 504, may be had in straight shank; or in taper shank, non-expansion type, as No. 515.

Peerless Expansion Shell Reamer No. 520

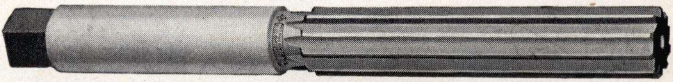
The only expansion high speed shell reamer on the market. May be had, also, in non-expansion type, as No. 519.



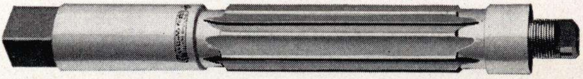
Miscellaneous Reamers

It is hardly possible, in a book of this type, to show all the different styles of Cleveland Reamers, but you will find below, and on the following page, a few examples of tools widely used and with which nearly everyone, sooner or later, comes into contact.

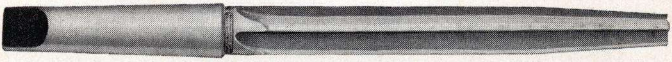
The question is often asked "What type of reamer ought I to use for this work?" We have a little folder, entitled "Selecting a Reamer" which we shall be glad to send to anyone interested upon request.



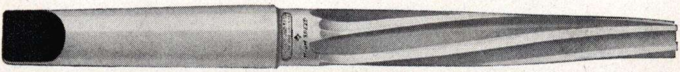
Hand Reamer No. 128A
A standard type of carbon steel hand reamer.



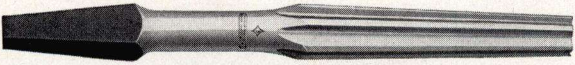
"Common Sense" Expansion Reamer No. 129
The most popular of carbon expansion reamers. It is widely used and particularly adapted for fine and accurate work.



Taper Bridge Reamer No. 150A
This is a taper shank reamer, with tapered flute and is especially designed for very severe service in structural iron and steel work, boiler-making, shipbuilding, etc. It is also to be had in high speed steel as No. 615 and with spiral flute as No. 616.



High Speed Taper Shank Car Reamer No. 618
This shows the Spiral Fluted type. The same reamer is made in Straight Flute as No. 617. Both types are widely used for volume production wherever a shorter flute reamer than No. 615 is desired.



Bit Stock Taper Reamer No. 137A
A Reamer, for use in brace or breast drill, and extensively used for radio and other fine work.

Taper Pin Reamers

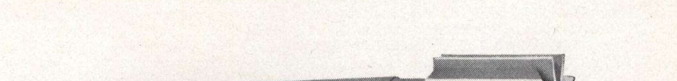
Standard Taper Pin Reamer No. 137

This reamer tapers ¼-inch per foot in all sizes; thus the point of each will enter the hole reamed by the next smaller size. Used for reaming holes for taper pins.

Spiral Fluted Taper Pin Reamer No. 139

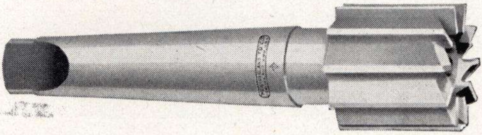
For those who prefer the spiral fluted taper pin reamer this type is furnished. It tapers the same as No. 137.

Miscellaneous Tools



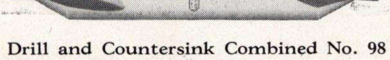
Taper Shank Counterbore No. 177

For counterboring for machine screw heads. These tools have interchangeable pilots, thus permitting one counterbore to be used for a number of screw sizes. Furnished, also, in high speed steel as No. 877.



End Mill No. 149

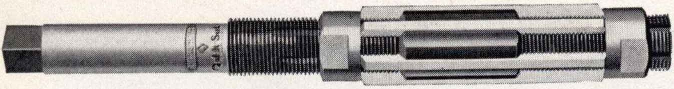
End mills are furnished in several styles for a wide range of uses, both in carbon and high speed steel.



Drill and Countersink Combined No. 98

A staple, handy tool that drills and countersinks at a single operation. Furnished, also in high speed steel as No. 998.

Quick-Set
Adjustable Reamer
TRADE MARK REG. U.S. PAT. OFF.



Quick-Set Adjustable Reamers are manufactured for garage and repair shop use. These shops require a reamer with wide limits of adjustment and sturdy construction.

Quick-Set bodies are made of tough machinery steel. The two ends of the body are threaded for nuts. The reamer is adjusted by loosening one nut and tightening the other. This moves the six blades in their slots.

The blades of Quick-Set are so accurately made and ground that, when they are worn out, they may be replaced by the garageman without grinding or fitting.

The ranges of expansion of the various sizes of Quick-Set Reamers are as follows:

Size	Range of Expansion
4-A	$\frac{3}{8}$ to $\frac{13}{32}$
3-A	$\frac{13}{32}$ “ $\frac{7}{16}$
2-A	$\frac{7}{16}$ “ $\frac{15}{32}$
A	$\frac{15}{32}$ “ $\frac{17}{32}$
B	$\frac{17}{32}$ “ $\frac{19}{32}$
C	$\frac{19}{32}$ “ $\frac{21}{32}$
D	$\frac{21}{32}$ “ $\frac{23}{32}$
E	$\frac{23}{32}$ “ $\frac{25}{32}$
F	$\frac{25}{32}$ “ $\frac{27}{32}$
G	$\frac{27}{32}$ “ $\frac{15}{16}$
H	$\frac{15}{16}$ “ $1\frac{1}{16}$
I	$1\frac{1}{16}$ “ $1\frac{3}{16}$
J	$1\frac{3}{16}$ “ $1\frac{11}{32}$
K	$1\frac{11}{32}$ “ $1\frac{1}{2}$

Quick-Set Reamers are packed in a number of attractive sets, each designed to meet the requirements of shops of varying sizes

EZY-OUT

TRADE MARK REG.
U.S. PAT. OFF.

SCREW EXTRACTORS

Until the invention of the EZY-OUT SCREW EXTRACTOR, the removal of a broken set or cap screw, stud, pipe fitting, etc., was one of the most annoying and exasperating of jobs.

But with EZY-OUT it is necessary merely to drill a hole in the broken screw, insert EZY-OUT, slip on a tap wrench and *twist* (left-hand), whereupon EZY-OUT's taper spirals *grip* the sides of the broken screw like so many steel fingers, and back it out on its own threads in a fraction of the time hitherto required by the makeshift methods of the past. EZY-OUT does not damage the threads of the hole and, therefore, re-tapping is never necessary.

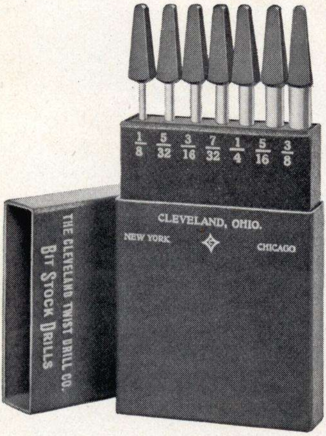
EZY-OUT
SCREW
EXTRACTORS AND STRAIGHT SHANK DRILLS
THE CLEVELAND TWIST DRILL CO.
No. 20

Set No. 20

This is Ezy-Out Screw Extractor complete set for general work, containing sizes from 1 to 6, together with drills for each size.

There are 12 Ezy-Out sizes altogether, but the larger sizes are intended for very large and heavy duty.

Tools in Handy Sets



Bit Stock Drills
Set No. 14B

This set consists of seven bit stock drills (No. 114 style, as shown on page 38) in the following sizes:

1/8, 5/32, 3/16, 7/32, 1/4, 5/16, 3/8 inch.

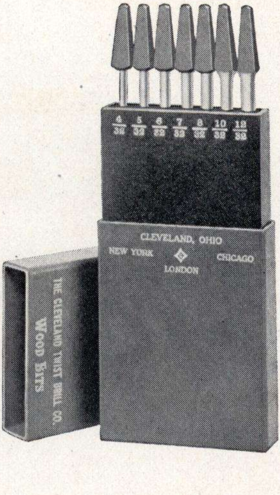
The set is contained in a strong green leatherette case, gold embossed, and is of a handy size either for the pocket or the work bench.

Wood Bits
Set No. 13B

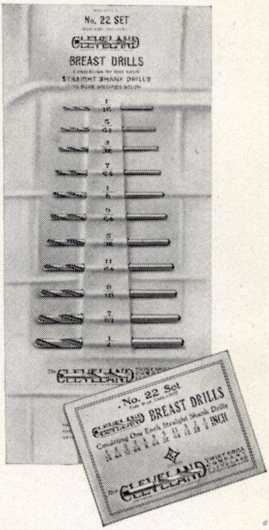
This set consists of seven wood bits (No. 114A style, as shown on page 38) in the following sizes:

4/32, 5/32, 6/32, 7/32, 8/32, 10/32, 12/32 inch.

The set is contained in a dark green corduroy silk covered case, embossed in gold, and is of a size handy for the pocket or the bench.



Tools in Handy Sets



Drill Set No. 22

This little set of jobbers' straight shank drills (No. 108, as shown on page 38) makes an irresistable appeal to automobile owners who do their own tinkering, to those who build and repair their own radio apparatus, to garage mechanics, machinists—in fact, to everyone who uses small drills for a thousand and one purposes.

Eleven small drills, from 1/16″ up to 1/4″, are contained in the set, which is wrapped in a tough fibre-cloth envelope.

Taper Pin Reamer Set No. 30

This set was especially designed for the automobile kit, or for anyone else doing a variety of small reaming jobs. It consists of sizes 0 to 5, all packed in a handsome wooden box, finished in dark maroon. The reamers used are No. 137, as shown on page 42.

The Spiral Fluted Taper Pin Reamer No. 139, also shown on page 42, can be furnished in a similar set.

The Little Doctor

A First Aid For Drill Press Operators

SYMPTOM	PROBABLE CAUSE	REMEDY
BREAKING of drill.	Spring or back lash in press or work. Too little lip clearance. Too low speed in proportion to the feed. Improper cutting compound.	Test press and work for rigidity. Regrind properly. Increase speed. Use proper cutting compound (see Par. 79-85). Use Cle-Forge Drills.
BREAKING down of outer corner of cutting edges.	Material being drilled is hard or dirty. Too much speed.	Reduce speed and try turpentine.
BREAKING of drill when drilling brass or wood.	Chips clog up flutes.	Use "Cleveland" drills for brass and No. 113A for wood. In ordering specify "for brass" or "for wood"
BURNING of the heel of the drill.	No lip clearance on drill.	Regrind properly.
BROKEN TANG.	Too much feed or, more probably, imperfect fit of taper shank in the socket — due to nicks, dirt, burrs or worn out socket.	Reduce feed — get a new socket or ream old one to prevent recurrence. Recover broken-tanged drill by use of "Perfect Double Tang Socket." Use Cle-Forge H. S. Drills No. 940.
CHIPPING of lip or cutting edges.	Too much feed. Too much lip clearance.	Reduce Feed — see table on page 33. Regrind properly.
CHIPPING or checking of a high speed drill.	Heated and cooled too quickly while grinding or while operating.	Warm slowly before using Do not throw cold water on hot drill while using or grinding.
CHANGE in character of chips while drilling.	Change in condition of the drill such as chipping of cutting edge, dulling, etc.	Regrind drill and correct the speed.
DRILL REFUSES to enter work.	Dull drill. Hard material. Too little lip clearance.	Sharpen drill. Use proper lubricant. Regrind properly.
HOLE larger than drill.	Unequal angle or length of the cutting edges — or both.	Regrind properly.
ONLY one lip cuts.	Unequal length or angle of cutting lips or both.	Regrind drill properly.
ROUGH HOLE.	Dull or improperly ground drill. Lack of lubricant or wrong lubricant.	Lubricate or change lubricant.
SPLITS up center.	Too little lip clearance. Too much feed.	Regrind with proper lip clearance. Reduce feed.

The Cleveland Twist Drill Co.

New York Cleveland Chicago London

AD 101-50-M-3-25

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NB agf 25-24-22

TRADE MARK
REG.U.S.PAT.OFF.